Technical Feature

Using DSP Software for VHF Beacon Monitoring

by Tim Kirby, G4VXE*

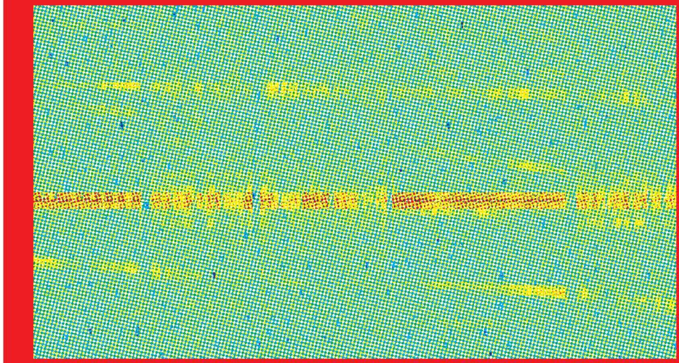

Fig 1: GB3VHF monitored using the *EasyGram* software, using around 300Hz bandwidth.

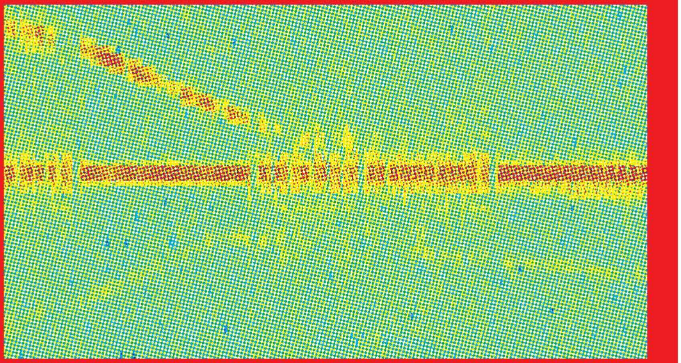

Fig 2: GB3VHF monitored in a narrower bandwidth (50Hz).

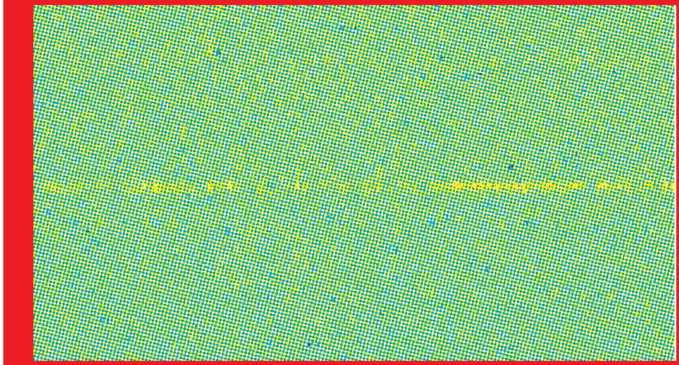

Fig 3: GB3ANG monitored in 100Hz bandwidth.

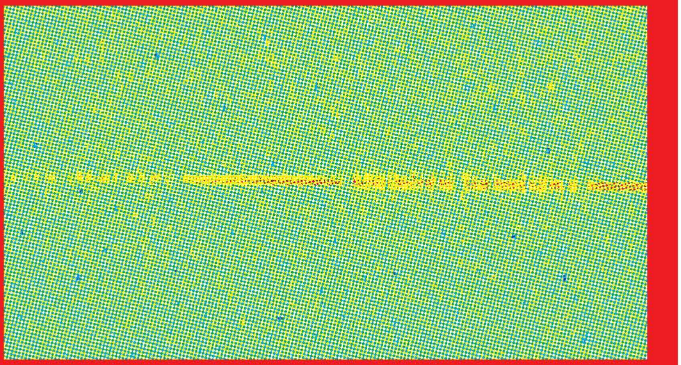

Fig 4: GB3ANG monitored via aircraft scatter.

THIS ARTICLE is intended as a very simple introduction to DSP software and techniques in a practical sense on the VHF bands. It is also intended to show that the techniques used by 'big' stations are just as applicable in a more modest environment.

Here at my home QTH, a small flat in Windsor (IO91QL), I do not have the room to erect a large 144MHz antenna. Pretty much the best I can do is an HB9CV on a small pole on the balcony. However, I am blessed with a good take-off from the south all the way around to the north. Another feature of interest is the frequent arrival and departure of aircraft from London's Heathrow airport.

USING DSP SOFTWARE

OVER THE LAST few months, I casually monitored various VHF beacons, mostly GB3VHF, situated in Wrotham (JO01DH), some 65km from home. Of course, this is simple, even with a small antenna such as mine. However, I was able to notice the effects of aircraft, tropo and other propagation modes creating a significant variation in signal strengths over the path.

I wondered whether it would be possible for me to hear the GB3ANG beacon, situated at Angus in Scotland (IO86MN), some 600km away, with my simple station. I knew that with exceptional propagation it should be possible, but several attempts to hear anything in a few casual listening sessions in 'ordinary' conditions were abortive.

I thought DSP techniques could be useful for me. I was aware that 'large' VHF stations were using them for meteor scatter (MS) and ionoscatter tests. Why not, then, apply the same techniques to a small station? During the course of looking for some information on the world wide web, I came across Johan's, ON4ANT, pages [1]. There was a wealth of information there about the subject and his experiences of using a number of packages. I decided to try it out!

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In order to do so, you will need:

- VHF station: in my case, an FT-847 connected to an HB9CV antenna. You can probably do better.
- Computer, preferably Pentium or higher spec, with a soundcard.
- Connecting lead between the rig's audio output and the computer line-in jack.
- DSP software.

EASYGRAM

WHEN YOU'RE experimenting with software, at least in a hobby context, you probably don't want to pay for it! At least, I don't. So I selected some software called *EasyGram*, which Johan had mentioned on his web page. This is freeware and may be downloaded from the web [2].

Installation was simple and consisted of unzipping a few files into a directory and then running the *EasyGram* program.

The program provides a 'waterfall' display of what you are listening to: this concept will be very familiar to those that have used the excellent *DigiPan* software for decoding PSK31. In any event, it shows a graphical representation of what is in your receiver's bandwidth. Signals will show up as lines, which can be horizontal or vertical, depending on your preference. I decided horizontal lines were better. *EasyGram* also shows the strength of the signal. No signal or band noise shows up as green, weak signals as yellow and strong signals as red.

You can also save the waterfall display as an image file, which is nice if you want to show other people what you have heard, or keep records. I've used this feature to provide the examples in **Figs 1 - 4**.

The program can be configured to take an image picture on a timer basis, which may prove useful for monitoring signals on a more scientific footing, allowing the build up of history of propagation over a path.

The Scan tab allows you to configure the DSP parameters. They seem to be defaulted to values which might be more appropriate for LF working, which is, I think, where the program has been used primarily.

Just to get started, I suggest using the following settings: Gain 3db, Centre 680Hz and Width 300Hz, FFT 16384, Sample 44100 and Scale 90db. Once you become more familiar with the program, you will probably want to experiment with the settings, but use these for now.

TIME TO START LISTENING . . .

WHAT I SUGGEST to start with is to pick a beacon that you can detect 'audibly', at least most of the time. I used GB3VHF. An indication of the results is shown in Fig 1. Here you can see the main body of signal in red. The solid line is the steady carrier of the beacon. Where it is broken, CW characters are being sent. What is interesting is the faint yellow lines going diagonally. These, I think, show the Doppler shift on the signal due to aircraft coming in above me to land at Heathrow.

Having identified your beacon signal, let's play with the DSP a bit. Select the signal by placing the mouse on the line and then click. This will zoom into the centre frequency and narrow the bandwidth right down to about 30Hz. You'll see your received signal get wider - and if there's much in the way of strength, it'll probably go red. In Fig 2, the Doppler shift resulting from aircraft scatter is very clearly discernible, with the line coming from the top left-hand corner converging on the centre.

The other requirement at this stage is to calibrate your receiver. The reason that this is important is that if you are going to listen for a beacon that you can't easily hear, you'll need to be confident of your receiver's calibration. Again, I used GB3VHF, which I believe is quite accurate.

That was the easy bit. Now I moved my receiver VFO to the GB3ANG frequency, 144.453MHz. It was not 'audible'. To start with, I set the bandwidth on the DSP fairly wide. After a few seconds, I was able to see a weak but tell-tale line emerging across the screen (see Fig 3). The line was broken, rather than solid. This was good news, because it suggested that it was the beacon keying, rather than a spurious in my receiver or a 'birdie' in the locality. I was then able to centre on the frequency and move the bandwidth down to around 100Hz and the tell-tale line became clearer. The steady line across the screen showed me where the beacon is. Intriguingly, for most of the period of this sample, the beacon was inaudible to my ears. Signals were going up and down and I could occasionally copy the beacon audibly although rarely sufficiently to decode the CW identification, but the DSP was getting good copy of the beacon, probably approaching 50% of the time.

In Fig 4, you can clearly see the solid line showing the steady carrier of the beacon followed by the two periods of keying, once giving the callsign and the second giving the locator, before sending the carrier again. Note also, the slight downward slope of the signal from left to right, a difference of 7 or 8Hz over a beacon cycle. I concluded that this was because I was hearing the beacon via aircraft scatter as aircraft took off to the north, moving away from me.

FURTHER EXPERIMENTATION

THE WHOLE EXERCISE proved an excellent introduction to the field of DSP and a thought-provoking one in terms of what the term 'weak-signal' VHF working means today. Truly, there are times when our computers can hear better than we can. These techniques are being very effectively exploited by a small number of VHF / UHF specialists, but perhaps they may be of interest to the more average DXer.

DSP is being used in many facets of amateur radio. At LF, it can be used in conjunction with very slow speed Morse techniques. I highly recommend a look at Mike Dennison's, G3XDV, web pages [3] for a description of some of the experiments that he has made, along with images and sound clips of some of the LF signals. There are also links to other pieces of software such as *Spectrogram*.

If, like me, you used to enjoy meteor scatter contacts on 144MHz using high-speed CW you may be interested to read that variable speed tape recorders and keyers are no longer the norm. Instead, all this functionality can be achieved in software. Take a look at *MS-DSP* from 9A4GL [4]. There are some sound clips of high-speed CW that you can play with and decode. It's interesting stuff!

I encourage you to experiment with DSP techniques for weak signals if you have not already done so. It is very simple but the results are fascinating. The experiments I described are suitable for those of us with a small VHF station. If you have a larger antenna, such as a 9-element or bigger, then you may be able to set your sights higher in terms of an even more distant beacon to monitor. ◆

WWW.

[1] Johan's, ON4ANT, pages:	**http://www.qsl.net/on4ant**
[2] *EasyGram* software:	**http://mujweb.atlas.cz/www/ok1fig/easygram.htm**
[3] Mike's G3XDV, LF pages:	**http://www.lf.thersgb.net/**
[4] 9A4GL pages (*MS-DSP*):	**http://ham2.irb.hr/9a4gl/**

FURTHER READING

The VHF / UHF DX Book, edited by Ian White, G3SEK
Guide to VHF / UHF Amateur Radio, by Ian Poole, G3YWX
The VHF / UHF Handbook, edited by Dick Biddulph, G8DPS (M0CGN).